INVESTIGATOR'S ANNUAL REPORT

United States Department of the Interior

National Park Service

All or some of the information you provide may become available to the public.

OMB # (1024-0236)
Exp. Date (11/30/2010)
Form No. (10-226)

Reporting Year:	**Park:**	**Select the type of permit this report addresses:**
2006	Shenandoah NP	Scientific Study

Name of principal investigator or responsible official:	**Office Phone:**
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Additional investigators or key field assistants (first name, last name, office phone, office email)

Name: Dr. Mike Deaton **Phone:** 540-568-2725 **Email:** deatonml@jmu.edu

Project Title (maximum 300 characters):

Field Measurements of Metabolic Indices During Hiking

Park-assigned Study or Activity #:	**Park-assigned Permit #:**	**Permit Start Date:**	**Permit Expiration Date:**
SHEN-00271	SHEN-2002-SCI-0023	Mar 15, 2002	May 31, 2008

Scientific Study Starting Date:	**Estimated Scientific Study Ending Date:**
Mar 15, 2002	May 31, 2008

For either a Scientific Study or a Science Education Activity, the status is:

Continuing

For a Scientific Study that is completed, please check each of the following that applies:

__ A final report has been provided to the park or will be provided to the park within the next two years

__ Copies of field notes, data files, photos, or other study records, as agreed, have been provided to the park

__ All collected and retained specimens have been cataloged into the NPS catalog system and NPS has processed loan agreements as needed

Activity Type:

Research

Subject/Discipline:

Other

Purpose of Scientific Study or Science Education Activity during the reporting year (maximum 4000 characters):

I plan on hiking this section of the AT twice in order to compare metabolic differences when hiking with and without trekking poles. At the same time time, I will be using the newest generation of triaxial accelerometers that allows long-term measurement of physical activity. The accelerometer records activity counts in three planes of movement, which are used as the basis to estimate energy expenditure. Several outcomes will result from this project. First, it provides a way to map the AT in terms of energy expended and thus lends additional information for planning in terms of food (calories necessary) and overall effort. Second, it provides an extended analysis of the overall effect trekking poles have in terms of energy expenditure during backpacking. Third, it will provide a field comparison of measuring metabolism directly or indirectly via the Cosmed K4b2 metabolic unit versus the RT3 Triaxial Accelerometer. The combination of these instruments allow for more realistic field measurements of energy expenditure. A unique feature of the Cosmed K4b2 is the inclusion of a 12 channel GPS unit that integrates speed, distance, and altitude with the metabolic data.

Other extensions for this project are being considered as well. In my conversations with the head ranger of Geographic Information Systems for the Shenandoah National Park, he expressed interest in developing a grading system for all of the trails in the park based on measures of energy expenditure. In an effort to assist park visitors with accurate hiking information, a rating scale can advise hikers of the actual difficulty of trails they choose to hike. Obviously, this aspect of the study would be a long-term project.

The results of this study will be disseminated through subsequent publications and presentations.

Findings and status of Scientific Study or accomplishments of Science Education Activity during the reporting year (maximum 4000 characters):

Title:

Comparison of Post-Exercise Metabolism for Extended Hiking and Road Cycling

David L. Wenos & Michael L. Deaton, CISAT, James Madison University

The purpose of this study was to determine if differences existed in post-exercise metabolism following extended weight bearing and non-weight bearing activities.

Methods:

Two experienced male backpackers (52 yrs, 72 kg, 173cm, VO2peak 57.7 ml.kg-1.min-1; 35 yrs, 74.8 kg, 187.96 cm, VO2 peak 60.87 ml.kg-1.min-1) hiked a 60 mile section of the Appalachian Trail over six days. An altimeter was used to record altitude during hiking. The average time hiked per day was 3 hours 48 minutes with an average temperature of 11.2 C and relative humidity of 48.5%. Resting metabolic rate was taken prior and immediately following each hike with the MedGem (FDA 510K-cleared Class II medical device) hand held indirect calorimeter. Calibration procedures were followed prior to each measurement. Resting metabolism was also measured each day upon wakening for six days following the hike. During the post hike period, activity levels were limited to daily living activities and excluded exercise.

Results:

During the 60 miles of hiking there was a general linear increase in RMR by an average of 213.3Â±72.9 kcals/day for both hikers. Two parallel increases in RMR occurred on Day 3 of the hike (105 kcals/day) and Day 1 of recovery (155 kcals/day) for both hikers. For six days following the hike, recovery RMR continued to remain elevated and exceeded the initial RMR taken prior to the first hiking day. During recovery, there was a gradual linear decline in RMR by an average of 14.3 kcals/day. A linear pattern in RMR was not observed during the 360 miles of road cycling. Although RMR increased overall during the seven days of cycling (476+172.6 kcals/day), RMR alternated between rising and falling from theprevious daysâ ride. For the cyclist, two distinct increases in RMR occurred on Day 3 and Day 5. Post-ride recovery RMR averaged 40.6 calories, approaching pre-ride RMR values.

Conclusions:Numerous factors affect energy expenditure during physical activity. During hiking, the terrain surface, footwear, constant stride length changes, and pack weight each contribute to an increase in RMR over consecutive days. For example, each hiker pack weight represented 15% of total body weight. Normally, walking the downhill portion of a mountain hike requires less work. However, energy cost begins to increase during repeated sections of downhill grades. Hiking downhill requires proportionally greater eccentric muscle contraction and is associated with increased muscle fiber damage and extended recovery. Therefore, the elevated RMR of the recovery days which exceeded the initial RMR taken prior to the first hiking day, appear consistent with muscle repair and recovery. The alternating pattern for cycling RMR was attributed to either a significant amount of climbing or descending terrain ridden for that day. Although the road cycle trip was 300 miles longer than the Appalachian Trail hike, it did not exhibit the same magnitude in post-ride RMR. Road cycling represents a non-weight bearing activity that has benefited from concerted research efforts to improve cycling efficiency. Factors that contribute to this efficiency include changes in drag due to changes in bicycle configuration, wheel and tire stiffness/composition that improve rotational kinetic energy, drafting techniques, pedaling frequency,

and helmet ventilation configurations. The quick return to near pre-ride RMR values, during recovery, suggests important differences in RMR between weight and non-weight activities over consecutive days. From a training perspective, these results suggest that the resumption of extended road cycling might not affect performance. Whereas, resuming extended hiking may require a longer recovery or modifying daily mileage.

For Scientific Studies (not Science Education Activities), were any specimens collected and removed from the park but not destroyed during analysis?

No

Funding specifically used in this park this reporting year that was provided by NPS (enter dollar amount):	**Funding specifically used in this park this reporting year that was provided by all other sources (enter dollar amount):**
$0	$0

List any other U.S. Government Agencies supporting this study or activity and the funding each provided this reporting year: